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Graph Neural Network Triggers for □ -> 3□ Events at the HL-LHC

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A graph neutral network (GNN) was constructed to identify charged lepton flavor violating decays of a tau particle into three muons in proton-proton collisions recorded with the CMS detector of the Large Hadron Collider. The muons from this decay are expected to have very low momentum, making them hard to detect in the high pileup environment expected at the high luminosity LHC (HL-LHC). We therefore propose the use of a GNN to select signal candidate events for readout and storage in the Level-1 trigger system during the run of the HL-LHC. Current standard model calculations indicate that the □ -> 3□ decay is extremely improbable with a branching ratio of ˜O(10-55), but some beyond-the-standard-model (BSM) physics models predict a much larger branching ratio of ˜O(10-8). A large trigger acceptance for these events is crucial to maximize sensitivity to this potential signal of BSM physics. For this purpose, a GNN trigger was developed. The trigger' s performance was evaluated by determining the projected yield of accepted signal events at various trigger rates in two phase spaces of interest and comparing to current CMS algorithms. Over the lifespan of the HL-LHC, the GNN trigger is projected to accept ˜80k signal events at a trigger rate of 77kHz, greatly improving the current trigger's projected yield of ˜16k events at the same rate. The graph neural network's high performance makes it a strong candidate for use in the CMS trigger system to enhance the discovery potential for BSM physics.

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